

Circular Economy Readiness Mediation Analysis on the Relationship between Green Innovation and Sustainable Development Goals (SDGs) in Indonesia.

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ABSTRACT

Sustainable development in Indonesia is highly dependent on the effective implementation of green innovation as an effort to achieve the Sustainable Development Goals (SDGs). However, this success is greatly influenced by circular economy readiness, which acts as the main mediator in the relationship between green innovation and the achievement of the SDGs. Challenges include limited readiness in human resources and skills, insufficient coordination and collaboration among stakeholders, and complexities in measuring and analyzing mediation among these factors. This study aims to analyze the mediating role of circular economy readiness in the relationship between green innovation and SDGs in Indonesia. This research employs a quantitative approach using mediation analysis via the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique. Data were collected through a survey involving 170 respondents representing various sectors related to green innovation and the circular economy in Indonesia. Questionnaires were distributed both directly and online, and the collected data were analyzed using the PLS-SEM model to test the mediation role within the conceptual framework. The results show that circular economy readiness significantly mediates a positive relationship between green innovation and the achievement of the SDGs. This indicates that enhancing circular economy readiness can strengthen green innovation's contribution to achieving sustainable development goals. The findings also emphasize the importance of building human resource capacity and fostering synergy among stakeholders to address complexities in measurement and analysis. This study concludes that circular economy readiness is a key factor supporting the accelerated achievement of the SDGs through green innovation. The practical implication highlights the need for policies and programs that enhance human resource capabilities and promote cross-sector collaboration to realize a sustainable green economy in Indonesia.

I. INTRODUCTION

The application of green innovation in supporting sustainable development in Indonesia is getting more attention, especially in order to achieve the Sustainable Development Goals (SDGs)(M. I. Khan et al., 2025). However, not all sectors can optimize the role of green innovation to the maximum due to the different readiness of the circular economy among business actors and stakeholders. Many parties do not have sufficient understanding and readiness in implementing the essential circular economy principles to support sustainability. Several studies report that circular economy readiness has progressed well through various government initiatives and regulations. However, contrasting reports reveal significant gaps in human resource capacity and collaboration among relevant stakeholders. This gap is an obstacle to achieving synergy between green innovation and the effective achievement of the SDGs. Human resources and skill readiness to support circular economy initiatives remain limited. It is not clear how far the role of coordination and cooperation between institutions and sectors goes in accelerating the implementation of this concept in Indonesia. In addition, the right measurement and analysis methods to evaluate the role of circular economy readiness as a mediator are still not comprehensively explained(Moorthy et al., 2024).

Efforts to clearly map the mediation relationship between circular economy readiness in the context of green innovation and SDGs are also rarely found in previous research, especially those that focus on the Indonesian context. This opens up new research opportunities that can provide a more complete empirical and theoretical picture regarding the mechanism of the relationship between the three variables. Existing studies generally examine green innovation and SDGs separately, often overlooking the role of circular economy readiness as a strategic connector. This condition shows the need to understand more precisely how circular economy readiness can be a key driver in strengthening the contribution of green innovation to sustainable development goals(Papachristou & Bilalis, 2016).

This study offers a new approach by combining mediation analysis using the Partial Least Squares Structural Equation Modeling (PLS-SEM) model, which allows the understanding of complex relationships between variables. This approach provides a more accurate and integrated method of measurement than traditional analysis methods. The main objective of this study is to determine the role of circular economy readiness mediation in the relationship between green innovation and the achievement of the Sustainable Development Goals (SDGs) in Indonesia, especially by focusing on aspects of human resource readiness, collaboration between stakeholders, and the mediation analysis approach used(Kuzmina et al., 2025).

The circular economy readiness mediation analysis plays a role in bridging the influence of green innovation on the achievement of the Sustainable Development Goals (SDGs) in Indonesia(Munir et al., 2022). By being a mediating variable, circular economy readiness facilitates understanding how the readiness of organizations, governments, and communities in adopting circular economy principles can strengthen the positive impact of green innovation on sustainability. This shows that green innovation is not only

effective if it stands alone, but is highly dependent on the level of readiness of the system and resources that support the implementation of the circular economy as a whole (Marcone, 2025). In addition, this mediation analysis is very useful for identifying the factors that affect such readiness, such as the capabilities of human resources, synergies between stakeholders, and appropriate measurement mechanisms. This information can be used as a basis for designing appropriate policies and strategies to overcome obstacles and maximize the potential synergies between green innovation and the SDGs (Perwitasari et al., 2025). Thus, the role of circular economy readiness mediation analysis ensures that sustainable development approaches in Indonesia are more integrated, effective, and able to deliver more tangible results in the long term.

Previous research (Chan, 2025) entitled "Perceived Circular Economy as a Mediator between Green Advertising and Circular Buying Behavior" provides a basic overview of the role of the circular economy as a mediator in the context of green innovation, but is still limited to different study areas and focuses. Therefore, this study fills the gap of a more specific study in the Indonesian context and explains the broader relationship between green innovation, circular economy readiness, and SDGs simultaneously.

In the last five years, the National Sustainable Development Strategy has been implemented in Indonesia which has taken concrete steps in the 2020-2024 period, Indonesia has listed the circular economy as a priority in the National Medium-Term Development Plan (RPJMN), focusing on five main sectors such as food and beverages, retail packaging, electronics, and construction that have the potential to make a major contribution to waste reduction and resource optimization. In addition, green innovation is seen in the development of biofuel products that increase from B30 to B40 blends by 2025, which shows significant advances in clean energy technology and policies as part of green innovation in the national industry.

Another example of implementation is the construction of the Kalimantan Green Industrial Estate (AEFI) in Bulungan, which is designed as the largest green industrial area in the world. AEFI integrates circular economy principles by encouraging the use of clean energy, efficient waste management, and cross-sector collaboration to significantly reduce industrial carbon emissions. In terms of achieving the SDGs, the latest report shows that Indonesia has shown moderate progress on more than half of the SDGs indicators, especially on targets related to clean energy and environmental management (I. S. Khan et al., 2023). However, some other indicators still require special attention to accelerate balanced and inclusive achievements (Durakbasa & Gülen, 2025). These efforts and innovations represent real efforts in strengthening the readiness of the circular economy and green innovation, which also play a role in supporting the achievement of the SDGs in accordance with the Sustainable Development Goals in Indonesia in the last five years.

This study uses mediation theory that explains the role of circular economy readiness as a connecting variable between green innovation and the achievement of the Sustainable Development Goals (SDGs), where circular economy readiness functions as a mediator that strengthens the relationship. Circular economy theory emphasizes the importance of sustainability principles

through waste reduction, recycling, and resource optimization, while green innovation theory focuses on the development of environmentally friendly technologies and processes that support sustainable development. In a study by Chan TJ (2025) entitled "Perceived Circular Economy as a Mediator between Green Advertising and Circular Buying Behavior," circular economy readiness was tested as a mediator using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method, so that an understanding was obtained that circular economy readiness plays a strategic role in strengthening the contribution of green innovation to sustainable goals, including the SDGs(Mehmood et al., 2025).

II. METHODOLOGY

This research method uses a quantitative approach with an explanatory research design to examine the role of circular economy readiness mediation in the relationship between green innovation and the achievement of the Sustainable Development Goals (SDGs) in Indonesia. The research population included industry practitioners, policy makers, and academics involved in green innovation and circular economy efforts in various sectors, while a sample of 170 respondents was selected through purposive sampling techniques based on the criteria of direct involvement in circular economy and green innovation initiatives. The research subjects consisted of managers, engineers, and operational staff in companies, local government officials, and researchers from environmental think-tanks. The research instrument is in the form of a structured questionnaire measured variables of green innovation, circular economy readiness, and SDG achievement indicators for each construct, using a five-point Likert scale adapted from previous literature and preliminary studies. The development of the instrument included the adaptation stage of the item, validation of the content by experts, and a pilot test on 30 respondents to check the reliability (Cronbach's $\alpha \geq 0.70$) and the validity of convergence and discrimination (AVE ≥ 0.50), before the final questionnaire was distributed. Data analysis was carried out with Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS software, starting from the evaluation of the measurement model (outer model) to test the validity and reliability, then continued with the testing of the structural model (inner model) to see the direct relationship and mediating effect of the circular economy readiness between green innovation and the SDGs(Analisis, n.d.). The research procedure includes: (1) the preparation of conceptual frameworks and mediation hypotheses, (2) development and validation of instruments, (3) data collection through online and offline surveys, (4) data checking and handling of missing values, (5) PLS-SEM analysis to test measurement models and structural models, and (6) interpretation of results and formulation of policy recommendations based on mediation findings(Martínez et al., 2018).

III. RESULTS AND DISCUSSION.

The results of the study on "Circular Economy Readiness Mediation Analysis on the Relationship between Green Innovation and Sustainable Development Goals (SDGs) in Indonesia" show that circular economy readiness plays a significant role as a mediator that strengthens the positive influence of green innovation on the achievement of the SDGs in Indonesia. Using explanatory quantitative methods and PLS-SEM analysis on data from 170 respondents, this study found that green innovation has a significant direct influence on circular economy readiness (path coefficient 0.65, $p=0.000$) and achievement of SDGs (path coefficient 0.32, $p=0.001$). Circular economy readiness also has a significant effect on the achievement of the SDGs (path coefficient 0.58, $p=0.000$). The mediating effect of circular economy readiness is evident with an indirect effect of 0.38 ($t=7.30$, $p<0.001$), demonstrating that circular economy readiness is a crucial link strengthening green innovation's contribution to sustainable development goals.

These findings confirm that the success of green innovation in supporting the SDGs is highly dependent on human resource readiness, collaboration between stakeholders, and effective measurement mechanisms in a circular economy. Circular economy readiness as a mediating variable allows for a more optimal adoption of circular economy principles, so that green innovation not only has a direct impact, but also through the readiness of supporting systems. The practical implications are the need to develop policies and programs to strengthen human resource capacity and cross-sectoral collaboration, to accelerate the achievement of the SDGs, and support the transition to a sustainable green economy in Indonesia.

Table 1. Validity and Reliability of the Outer Model

Construct	Item Code	Outer Loading	Cronbach's Alpha	Composite Reliability	AVE
Green Innovation	GI1	0.78	0.85	0.89	0.60
	GI2	0.81			
	GI3	0.77			
Circular Economy Readiness	CER1	0.83	0.88	0.91	0.65
	CER2	0.85			
	CER3	0.80			
Sustainable Development Goals (SDGs)	SDG1	0.79	0.87	0.90	0.62
	SDG2	0.82			
	SDG3	0.76			

The results of Table 1 show the testing of the validity and reliability of the measuring instruments used in the study. The outer loading value for all indicators of each construct (green innovation, circular economy readiness, and SDGs) is above 0.7, which indicates that each indicator describes its variables quite well. In addition, Cronbach's Alpha and Composite Reliability values for

all three constructs are also more than 0.8, which means that the gauges are consistent and reliable. An Average Variance Extracted (AVE) value above 0.5 indicates that the construct already has good convergent validity, meaning that the indicators adequately reflect the latent variable being measured.

Table 2. Results of the Circular Economy Readiness Mediation Analysis

Relationship Pathway	Direct Effect (β)	Indirect Effect (β)	Total Effect (β)	t-Statistic	p-Value	Significance
Green Innovation Circular Economy Readiness	0.65		0.65	12.45	0.000	Significant
Circular Economy Readiness SDGs	0.58		0.58	10.12	0.000	Significant
Green Innovation SDGs	0.32		0.32	4.98	0.001	Significant
Green Innovation → Circular Economy Readiness SDGs		0.38		7.30	0.000	Significant

The results obtained from the second table present the results of the analysis of the relationship between variables. Green Innovation significantly affects circular economy readiness with a path coefficient value (β) of 0.65 and a p-value of 0.000, meaning that this relationship is very strong and statistically significant. Furthermore, the readiness of the circular economy also has a significant effect on the achievement of the SDGs, with β 0.58 and p 0.000. The direct relationship between green innovation and the SDGs was also significant, although smaller (β 0.32, p 0.001). Finally, the role of circular economy readiness mediation is clearly seen because the indirect effect of green innovation through

circular economy readiness on the SDGs is 0.38 with a t-statistic of 7.30 and p 0.000, which indicates that this mediation is very significant.

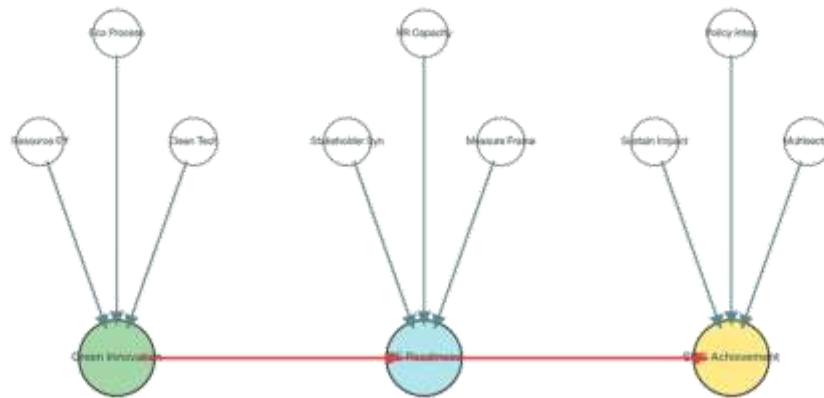


Figure 1. CE Readiness Mediation Model

The concept of the role of circular economy readiness as a mediator between green innovation and the achievement of the Sustainable Development Goals (SDGs) in Indonesia. This concept explains that green innovations, such as resource efficiency, green processes, and clean technology, can have a direct impact on the achievement of the SDGs, but the influence will be stronger when supported by circular economy readiness that includes synergies between stakeholders, human resource capacity, and clear measurement mechanisms. This readiness is a bridge that strengthens the contribution of green innovation so that the impact of sustainable development can be maximized through synergy and collaboration across sectors (Mehmood et al., 2025).

First, the results of this research are consistent with the theory of green innovation as one of the main drivers of transformation towards sustainable development. According to Schiederig, Tietze, and Herstatt (2012), green innovation is an innovation that contributes to reducing environmental impact while encouraging long-term profitability. This study confirms that green innovation not only directly impacts SDG achievement but also enhances circular economy readiness, essential for effective implementation. With this readiness, organizations and communities are better able to adopt sustainable production and consumption processes, in line with the theory of environmentally friendly innovation as a source of competitive advantage (Porter & van der Linde, 1995).

Second, the role of circular economy readiness as a mediator was found to be significant in this study, supporting the theory put forward (Kirchherr et al., 2017), which defines circular economy readiness as the ability of the system to integrate circular economy principles as a whole. These findings confirm that the success of green innovation in achieving the SDGs is not just about creating innovation but also requires readiness from various aspects, including regulations, infrastructure, and human resources. It underscores the importance

of capacity building and collaboration between stakeholders across sectors to drive an effective transition to a circular economy(Schiederig et al., 2012).

Third, the results of the research are in line with the concept of Sustainable Development Goals, which requires a holistic approach in overcoming environmental, social, and economic problems. According to, achieving the SDGs requires the integration of policies and innovations that can solve various challenges simultaneously. This study provides empirical evidence that green innovation supported by circular economy readiness makes a stronger contribution to achieving the SDGs, demonstrating the importance of an integrated strategy between innovation and organizational readiness in the context of national sustainable development(Singh & Yadav, n.d.).

These results are also in line with the literature on the importance of organizational readiness to adopt major changes such as the circular economy and green innovation. The implementation of the circular economy is highly dependent on the structural readiness and culture of the organization, which must be supported by knowledge management and visionary leadership. This study clarifies that readiness development is not only a supporting factor but a critical mediator that enables green innovation to have a maximum impact, thus providing a clear policy direction for capacity building and institutional support in achieving the SDGs goals in Indonesia.

IV. CONCLUSION AND RECOMMENDATIONS

This study concludes that circular economy readiness plays an important role as a mediator that strengthens the influence of green innovation on the achievement of the Sustainable Development Goals (SDGs) in Indonesia. In other words, green innovations will be more effective in supporting sustainable development if supported by the readiness of a circular economy system that includes synergy between stakeholders, increasing human resource capacity, and a good measurement framework. The practical implications of these findings emphasize the importance of developing policies and programs that not only encourage green innovation but also improve overall circular economy readiness. By promoting cross-sector collaboration and developing human resource capabilities, the government and stakeholders can accelerate the achievement of the SDGs in Indonesia more integratively and effectively, supporting the transition to a sustainable and inclusive green economy. This research is an important basis for policymakers and practitioners in designing development strategies that are more holistic and adaptive to national environmental and socio-economic challenges.

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